Development of a 7.62 mm Armor Piercing (AP) Projectile Using a Lean Design For Six Sigma (LDFSS) Process

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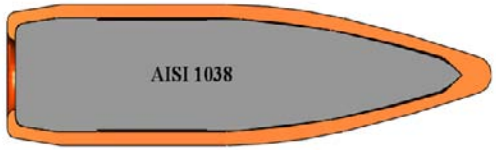
GENERAL DYNAMICS
Ordnance and Tactical Systems–Canada

Development of a 7.62 mm AP projectile using a LDFSS process

- OBJECTIVE
- APPROACH
- CONCEPTS
- RESULTS
- CONCLUSION

Development of a 7.62 mm AP projectile using a LDFSS process

- OBJECTIVE
  - To study a number of 7.62 mm AP projectile concepts with performances superior to those obtained with the 7.62 mm Improved Penetration (IP – 1038) cartridge.



  - Criteria for the new design
    - penetration > 19 mm RHA at 100 m at 0°
    - penetration > 6 mm RHA at 550 m at 0°
    - Same propellant charge and cartridge case as 7.62 mm C21 (Canadian equivalent to US 7.62mm M80)

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- APPROACH
  - BRAINSTORMING
    - Several meetings to establish a set of criteria
    - 12 concepts were proposed:
      - Different materials
      - Several geometries
      - Various penetrator and slug combinations
  - Used Pugh method to select concepts that satisfy the criteria
  - V_{50} trials for three of the selected concepts

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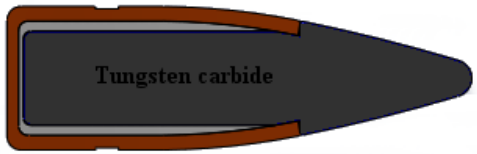
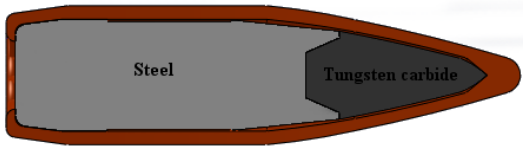
- CONCEPTS
  - Three most promising concepts selected:

M80 – T1

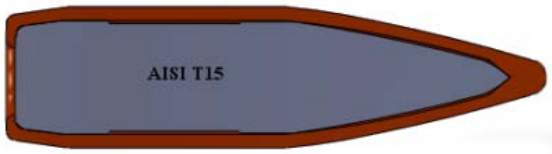


Open Jacket – Tungsten Carbide (WC)

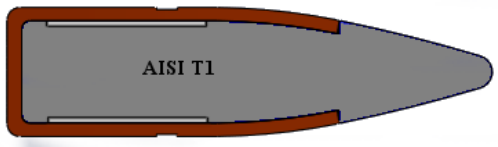


Two Parts – Tungsten Carbide (WC)

  - Two more concepts added to understand influence of materials on penetration :



M80 – T15



Open Jacket – T1

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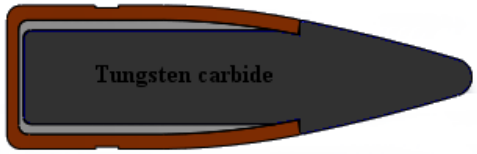
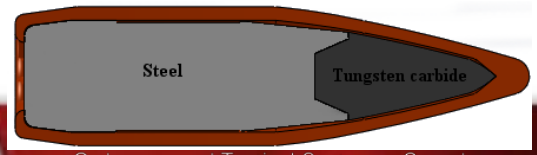
- Summary of concepts characteristics

Concepts	IP – 1038	M80 – T1	M80 –T15	Open Jacket – WC	Open Jacket – T1	Two Parts – WC
Total Weight (g)	8.40	8.44	8.40	9.21	9.04	8.46
Penetrator Weight (g)	4.91	5.01	4.95	6.31	5.67	1.25
Slug Weight (g)	N/A	N/A	N/A	N/A	N/A	3.85
Total Length (mm)	30.84	29.31	29.87	25.48	29.82	29.29
Hardness of Penetrator (RC)	57	60	67	71	60	71
Velocity at 24 m (m/s)	857	865	865	864	868	867





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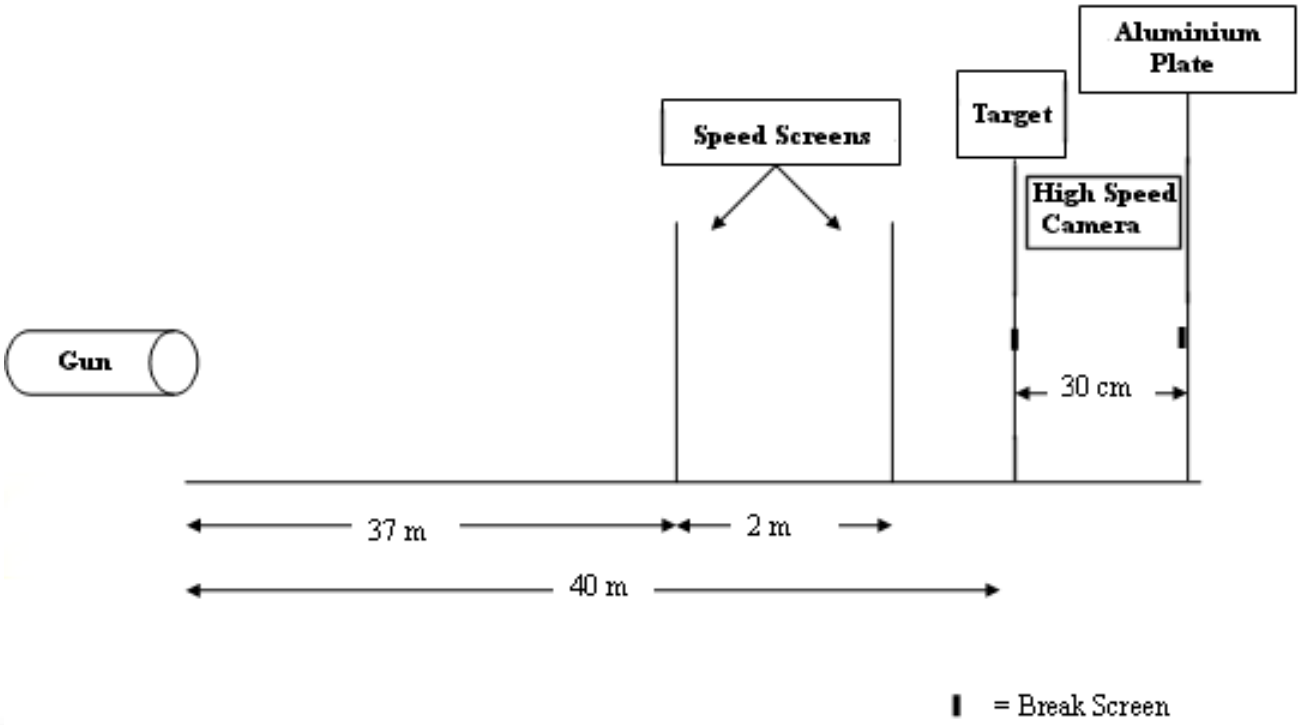
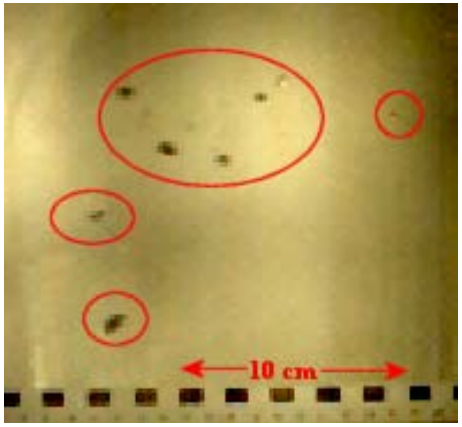
- Setup for penetration trial
  - Three different thickness (10 mm, 14 mm and 19 mm) of RHA steel plates
  - Hardness of the steel plate was 300 HB
  - Standard V_{50} trial setup
  - Impact velocity was measured at 38 m

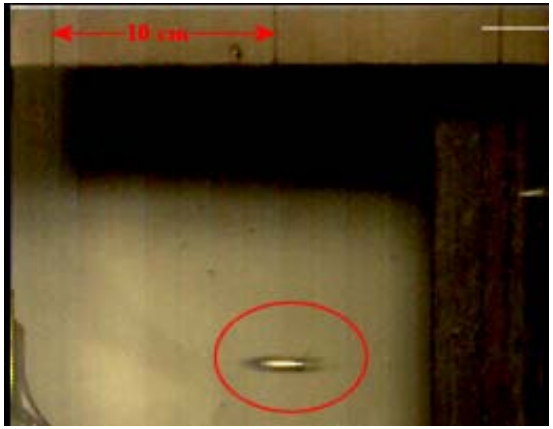


Development of a 7.62 mm AP projectile using a LDFSS process

- RESULTS
  - High speed camera pictures of projectiles in flight

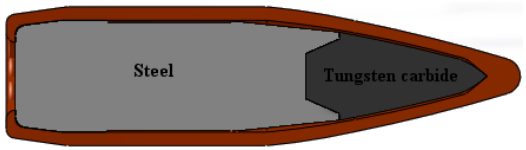


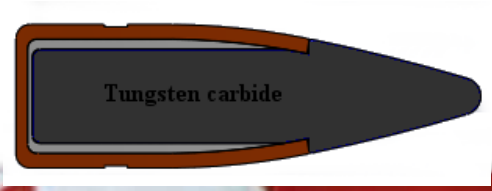
Two Parts – WC
•10 mm steel plate
•Impact Velocity : 804 m/s



Open Jacket - WC
•14 mm steel plate
•Impact Velocity : 688 m/s

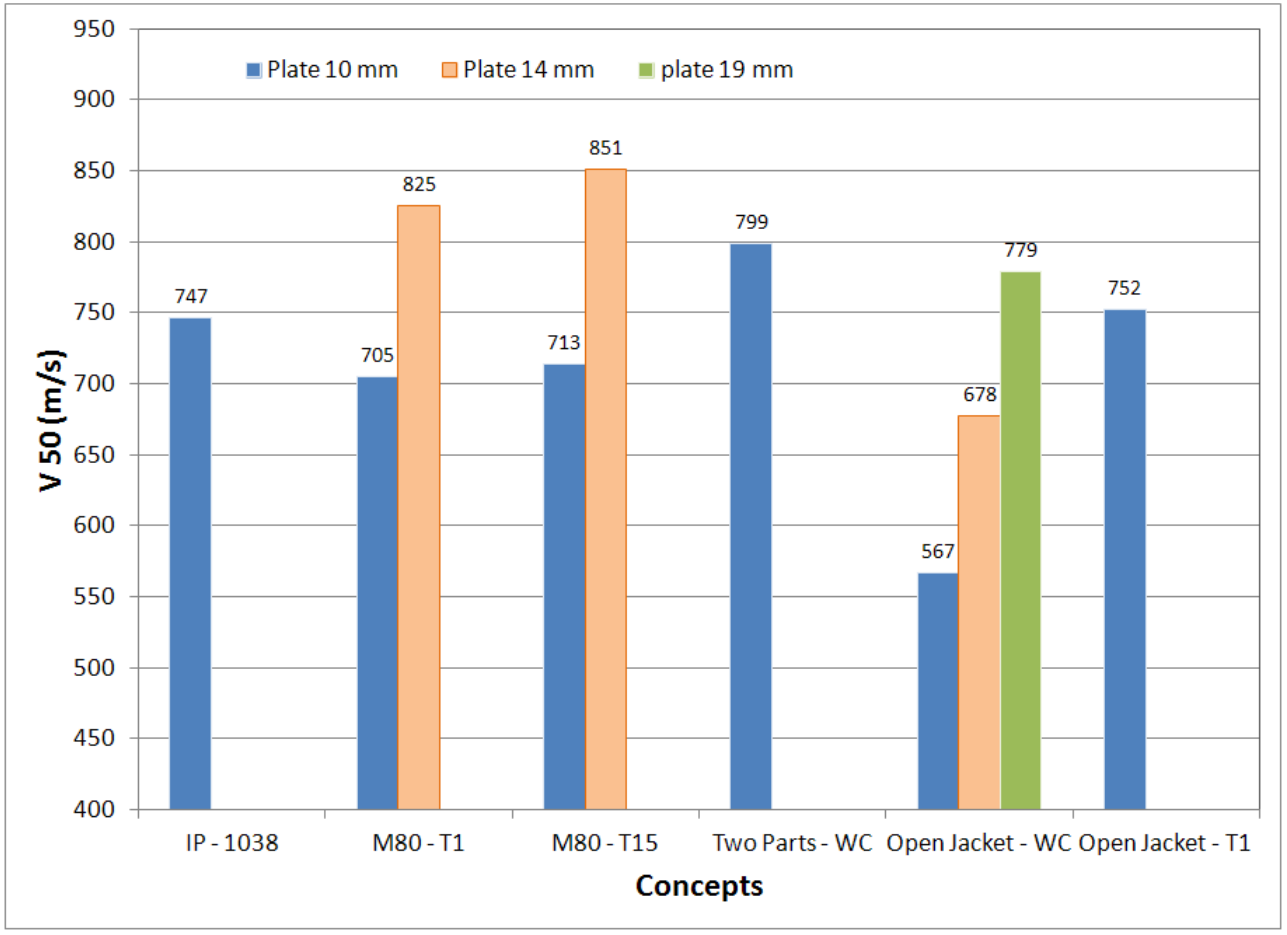
Open Jacket - WC
•19 mm steel plate
•Impact Velocity : 828 m/s





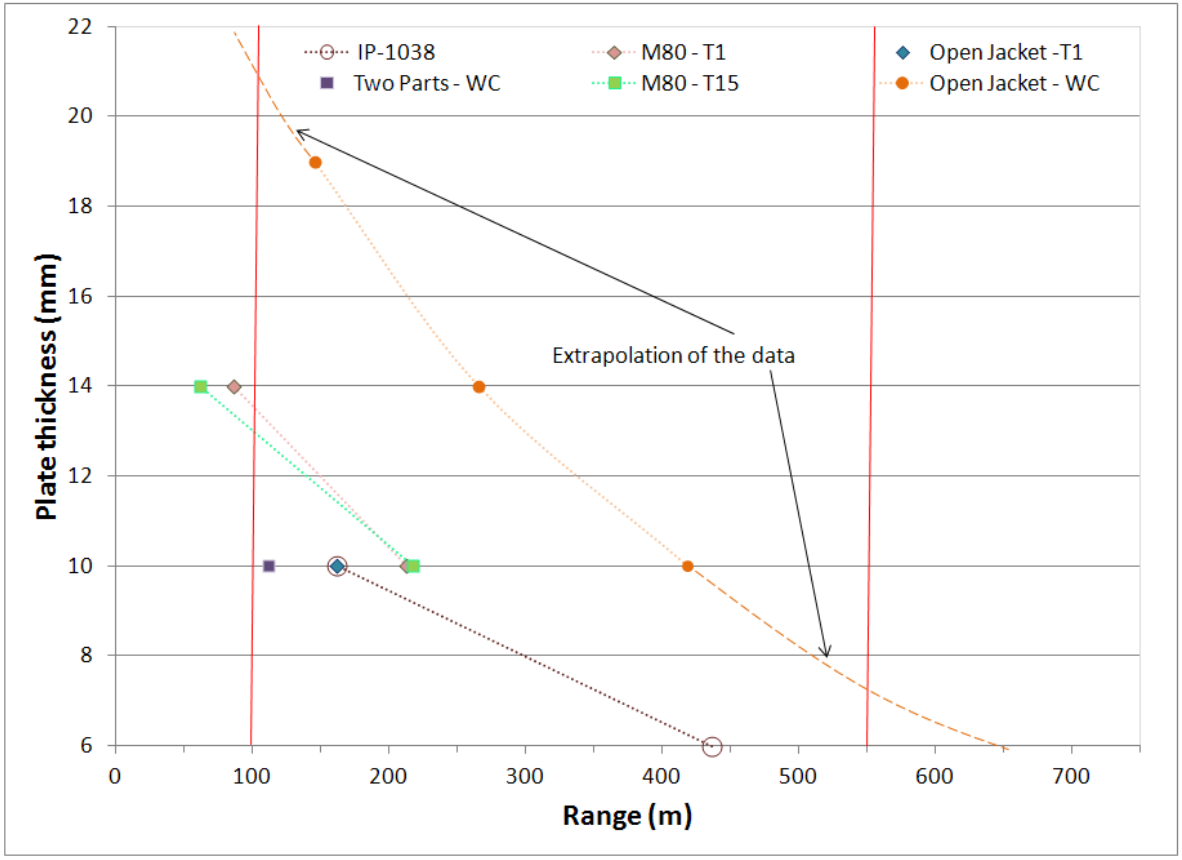
Development of a 7.62 mm AP projectile using a LDFSS process

- RESULTS
  - V_{50} measured for six rounds that penetrated and six rounds that did not penetrate the steel plates, within a velocity range of 40 m/s.
  - The Reference projectile was the in-house developed, 7.62 mm IP-1038.



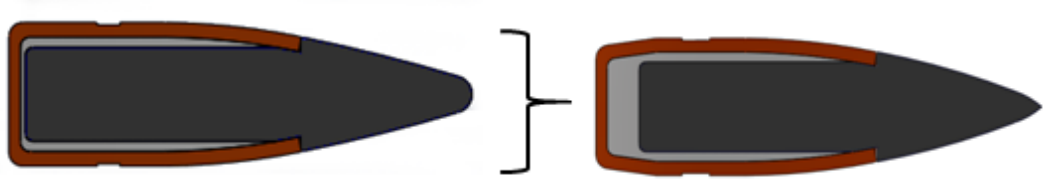
Development of a 7.62 mm AP projectile using a LDFSS process

- RESULTS
  - Range vs plate thickness
    - M80 – T1, M80 – T15 and OJ - WC are superior to the reference concept (IP - 1038)
    - OJ – T1 shows same performance as the reference concept
    - Two Parts – WC is inferior to the reference concept
    - OJ – WC performs the best among all concepts
      - Only concept that satisfies the two criteria
        - Penetration > 19 mm at 100 m and > 6 mm at 550 m.



Development of a 7.62 mm AP projectile using a LDFSS process

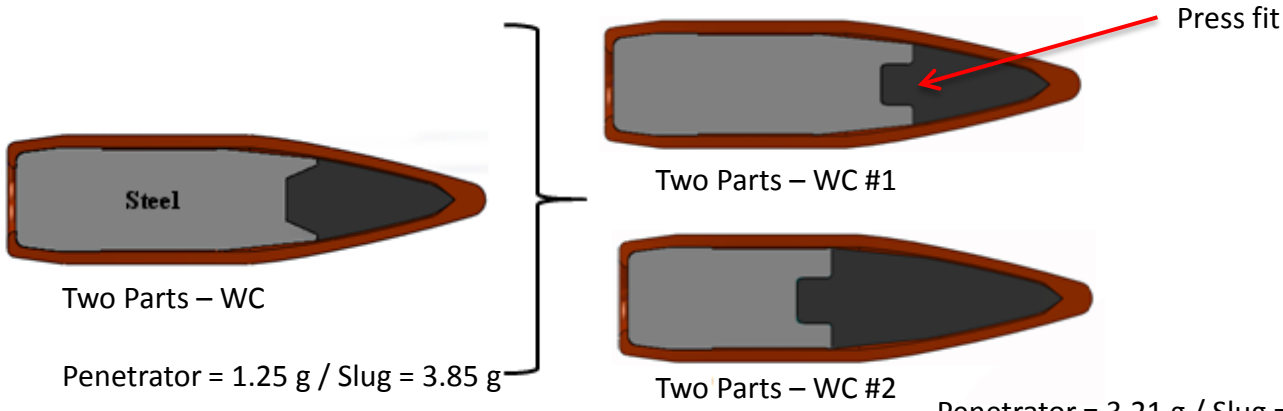
- Second iteration
  - Concept Open Jacket – WC with a more sharper nose (Influence of the geometry)



Open Jacket – WC

Open Jacket – WC #1

  - Two Parts – WC
    - Press fit linkage between the penetrator and the slug (Linkage of the penetrator)
    - Increased weight of the penetrator



Two Parts – WC

Penetrator = 1.25 g / Slug = 3.85 g

Two Parts – WC #1

Two Parts – WC #2

Penetrator = 3.21 g / Slug = 2.20 g

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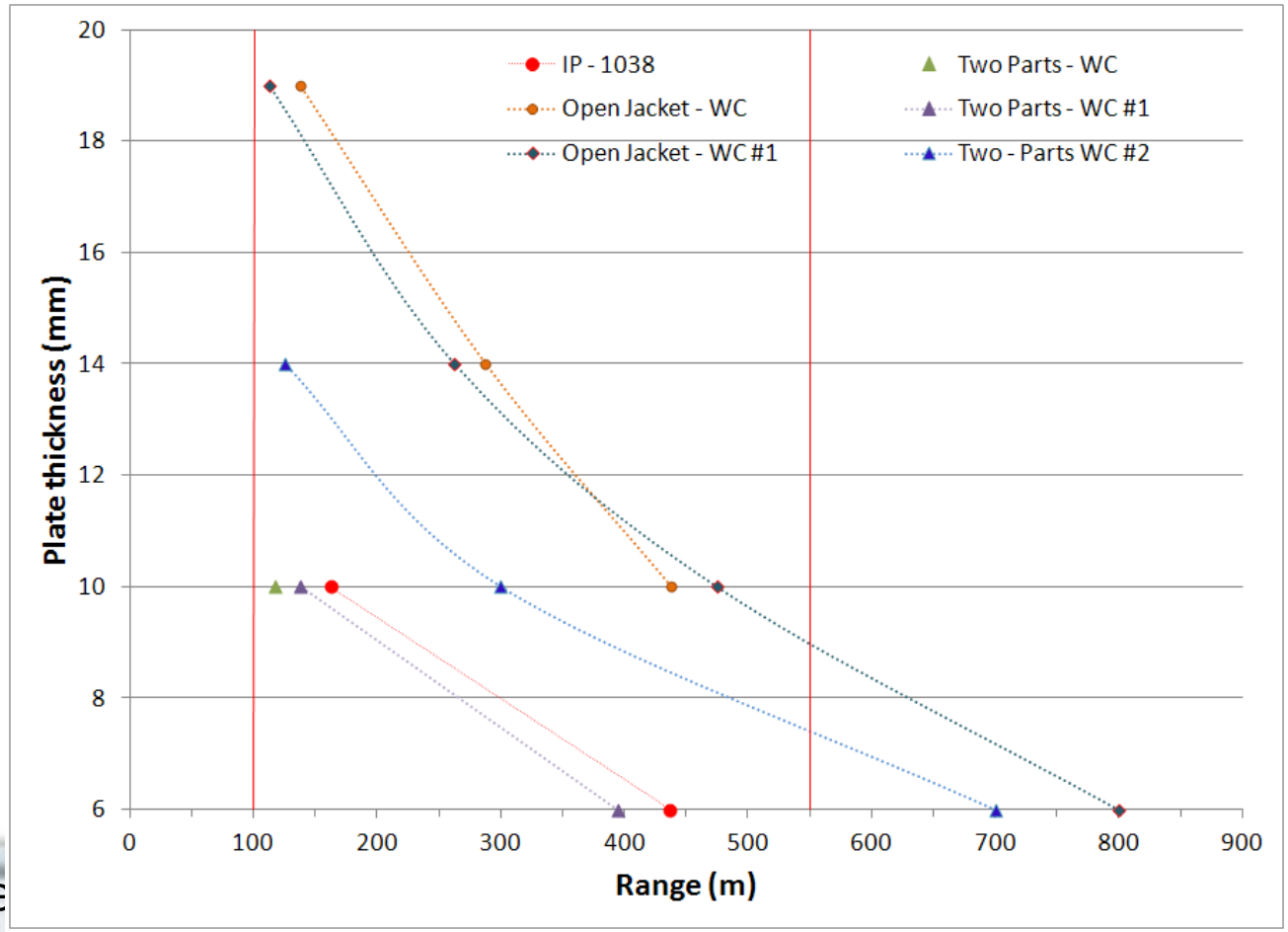
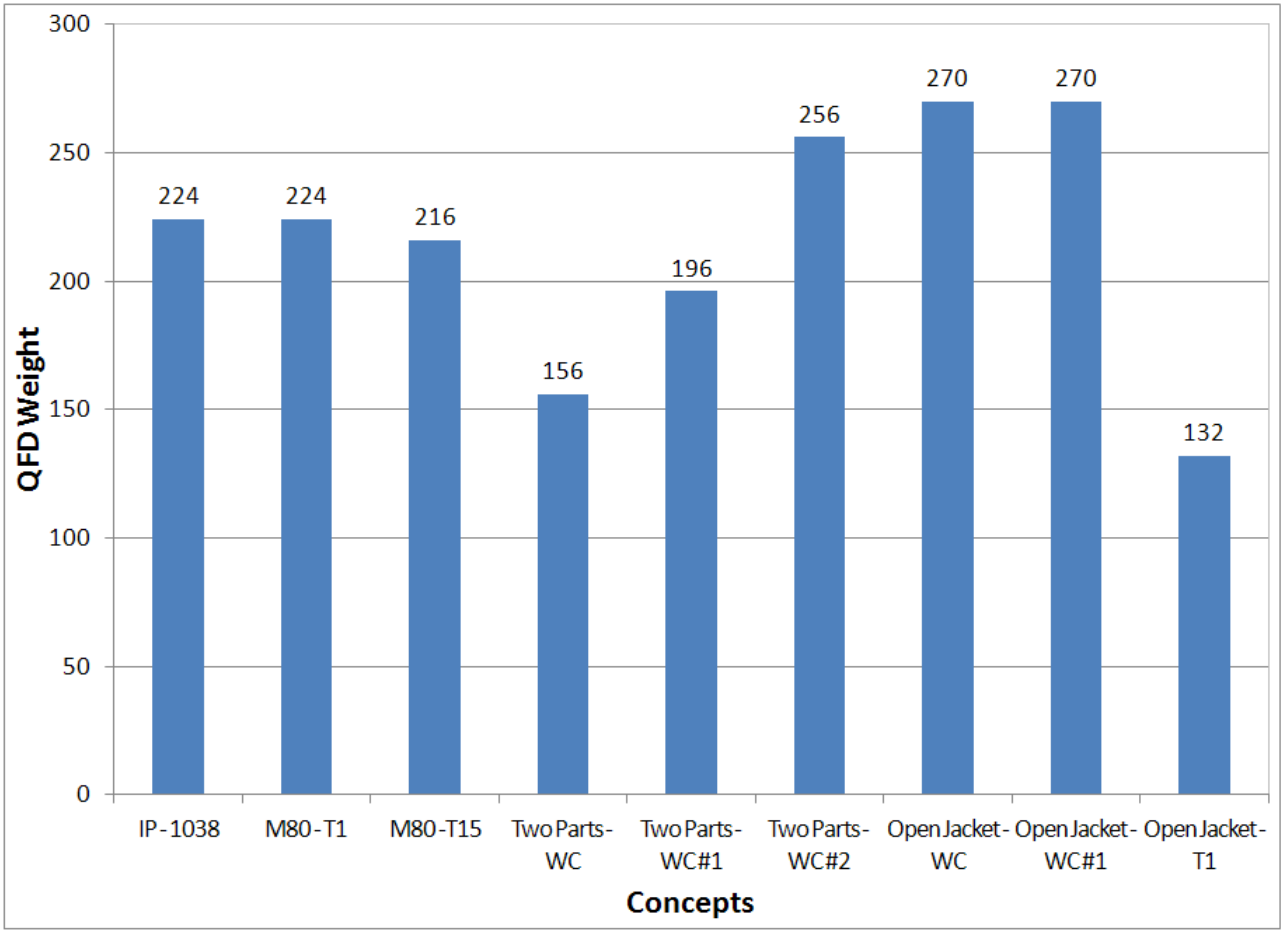
- Results of second iteration
  - Open Jacket – WC and Open Jacket – WC #1 show similar results
    - Penetrator geometry has little influence on penetration
  - Press fit linkage has an influence on penetration (Two Parts – WC and Two Parts – WC #1)
  - Penetrator weight significantly influences penetration (Two Parts – WC and Two Parts – WC #2)



Development of a 7.62 mm AP projectile using a LDFSS process

- RESULTS
  - Used Quality Function Deployment (QFD) to prioritize concepts
  - Higher QFD weight
    - Concepts Open Jacket – WC and Open Jacket – WC #1 were able to satisfy the penetration criteria
    - Concept Two Parts – WC #2 was able to penetrate a 14 mm steel plate at > 100 m
    - Concepts IP-1038, M80 – T1 and M80 – T15
      - Inexpensive to produce



Development of a 7.62 mm AP projectile using a LDFSS process

- Conclusions
  - The types of materials significantly influence penetration
    - Tungsten carbide gives good result (71 HRc).
    - The Hardness plays an important role on the penetration process. However, other mechanical proprieties may also have an influence since T1(60 HRc) and T15(67 HRc) have the same performance
  - The weight of the penetrator has a major effect on the performance of the projectile
  - The solidification of the linkage (Press fit) shows a better performance since the slug is able to transfer its momentum to the penetrator
  - The geometry of the penetrator has little influence

Further Information

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